STUDIES IN THE LIFE-HISTORIES OF AUSTRALIAN ODONATA.

No. 3. Notes on a new species of *PHYLLOPETALIA;* with description of nymph and imago.

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(Plate lv.).

Under the name of *Petalia apollo* Selys, I described, in 1906,* as new to the Odonate fauna of Australia, a remarkable insect, of which two females had been taken by Mr. G. A. Waterhouse, at Leura, Blue Mountains, in November, 1903. The type-specimens of *P. apollo* came from Chili, which is doubtless the natural habitat of this species. The fact that a species, apparently the same, had been taken in Australia, elicited much surprise, and also considerable doubt, amongst my European correspondents. However, I established beyond doubt that Mr. Waterhouse's captures were authentic; for he assured me that it was quite impossible that he had made a mistake in the matter, that he had never received any dragonflies from Chili, and that he distinctly remembered capturing them at Leura, the occasion being impressed on him by the unusual beauty of the insects themselves.

It remained, then, that someone should rediscover the insect, either in its old locality, or from a new district. During the few visits I have had to the Blue Mountains, I kept a sharp look-out for it. But I never succeeded in finding it until last November, when I saw a dragonfly, which was certainly of this species, flying at the top of Evans's Look-out, Blackheath. I was unable to capture it, but was near enough to see that it was a male, and that the colouring of both the wings and body was exceedingly

* "New Australian Species of the family *Æschnidæ*." These Proceedings, 1906, Vol. xxxi., p. 722.

beautiful. This was on November 7th. Two days later, during a heavy rainstorm, one of my pupils, Mr. Keith Brown, was out collecting crustacea at Leura Creek, with Mr. Alan McCulloch, Zoologist at the Australian Museum, when his attention was drawn to a dragonfly fluttering at the side of the cascades. It had evidently only lately emerged, and its wings were considerably knocked about. In a swirling pool of water near by, he found the larval skin; little knowing what a prize he had secured just in time, for soon afterwards the whole creek was a raging torrent, and the precious exuviæ would have been swept over the falls. Both imago and exuviæ were placed in alcohol, and brought to me in the hope that they might prove of interest.

I was delighted enough to have this material corroboration of Mr. Waterhouse's capture in the form of the imago; but that in itself pales into insignificance before the discovery of the larva, which is absolutely the first recorded larva ever found, of the remarkable *Petalia*-group of *Odonata*. I think all Odonatologists will be thankful to Mr. Brown for his great find, especially because it was out of a kindly interest in Nature and generous thought for the needs of someone else, that he, with no interest whatever in entomology, secured this great treasure.

During the rest of November and December, 1908, I visited the locality whenever possible, and kept a careful look-out for this rare insect. I also dredged carefully along the creek on each occasion. But I never found either larva or imago. Apart from giving a careful description of both, I am only able to say that there are two interesting points to be noted with regard to the species. The first is, that both Mr. Waterhouse's specimens were females, and so is that taken by Mr. Brown, and they were taken in exactly the same spot. The second is that they were all taken at the beginning of November, and that the insect has never been seen at any other period. It suggests to me a way of accounting for the extreme rarity of the insect. May not the imagines, directly after emergence (and in particular the males) disappear into the trackless forest, as is the case with some American *Gomphinæ*, and possibly never appear again on the creek

except for oviposition, and then only for a very brief period, and possibly during the early morning or late evening.

As to the identity of the insect with *Phyllopetalia apollo* Selys, I have compared the wing-patterns of the two species, and find several small differences. Just as in the *Gomphinæ*, it must be remembered that the wing-venation varies very little, not only amongst closely allied species, but even amongst groups of genera Hence, even if the wing-patterns of both species had absolutely corresponded, both in neuration and in the position of the spots, it would not have followed that they were the same species. As regards the body-colouration, that of Mr. Waterhouse's specimen was quite obliterated when I examined it; so that it was impossible to assert definitely that it was a new species. However, the markings of Mr. Brown's specimen, carefully preserved for some weeks in alcohol, are very clear indeed, and enable us with safety to compare it with the species described by Selys.

The description of Mr. Waterhouse's specimen will be found under the heading *Petalia apollo* Selys, on p.723 of these Proceedings for 1906, (Vol. xxxi). To that description it is now necessary to add the points in which Mr. Brown's specimen differs, and to give the full scheme of beautiful colouration which was obliterated in the former specimen.

That the insect is absolutely distinct from *Phyllopetalia apollo* Selys, but probably of the same subgenus, I am convinced. I propose to name it *Phyllopetalia patricia* in honour of my wife.

PHYLLOPETALIA PATRICIA, n.sp. (Plate lv., fig. 3).

Total length 57 mm; abdomen 42 mm; forewing 41 mm; hindwing 39 mm.

W i n g s beautifully spotted with brilliant deep crimson spots, placed as follows :—On all four wings a long narrow basal mark, receding from the costa, but reaching beyond the arculus to the fourth antenodal; in the submedian space the next cross-vein in forewing, and next three in hindwing are clouded with crimson; a rounded spot of smaller size is placed about half-way between base and nodus, and *on the forewing only* there is an even smaller

spot between this and the nodus. Enveloping the nodus is a large, somewhat squarish, irregular spot; half-way between the nodus and pterostigma a smaller squarish spot is affixed to the median vein but does not enter the costal space. *Exactly under* the pterostigma, but scarcely as long as it, is another large spot; finally, there is a large spot at the tip of the wing. Colouration of the head dark brown, with bright green transverse bands below the front and on the labium, these appearing yellowish-brown in the dead insect. Thorax reddish-brown, with six narrow straight stripes, all brilliant pea-green; the dorsal pair narrowest, the two lateral ones on each side broader and slightly paler. Abdomen rich reddish-brown, beautifully marked with bright pea-green as follows:—2, auricles green, a pair of oblong basal dorsal spots, a pair of larger oblong dorsal spots beyond the transverse carina, which is black, as are also the segmental sutures: 3-7, a pair of elongated basal dorsal marks, and on each side, low down, an elongated oval lateral spot; behind the transverse carina a pair of oblong dorsal spots; all the dorsal spots lying longitudinally in pairs, and on each side of the dorsal ridge: 8, basal dorsal marks reduced to small round spots; transverse carina absent, a pair of basal lateral spots as in 6, a pair of divergent oval anal dorsal spots: 9, a pair of elongated dorsal marks; 10, a pair of small dorsal spots: 8-9, slightly dilated below in lateral folds, those of 9 edged with green. Ovipositor large, thick, dark red, of distinct *Aeschnine* form, furnished with two divergent filaments, each formed by a rather thick basal joint 1 mm. long, tipped with a fine curved hair; between these, which are very wide apart, are two very finely curved hairs, also wide apart and divergent. Appendages short, 1 mm., wide apart; rather thick, black, slightly convergent, tips bent downwards and ending in a blunt point.

Hab.—Leura, Blue Mountains, N.S.W. (November).

This species is considerably smaller than any of the three Chilian species, though it comes nearest in size, and also in the pattern of its wing-spots, to *Phyllopetalia apollo* Selys. I have before me a photograph of the wings of this latter species, kindly

sent me by my friend, Dr. Ris. In the wing-spots the differences are as follows:—basal spot of *P. patricia* narrower than in *P. apollo*, but longer, reaching to beyond arculus and fourth antenodal, (that of *P. apollo* does not reach the second antenodal), but not keeping close to costa as in *P. apollo*. Second spot (intermediate between base and nodus) smaller than in *P. apollo*, scarcely touching the costa in hindwing and not at all in forewing. *Another roundish and somewhat smaller spot interposed, in forewing only, on the fourth antenodal from the nodus* is found only in *P. patricia*, and not in *P. apollo*. Third (nodal) spot shorter and squarer than in *P. apollo*, covering only one postnodal instead of two. On all four wings in *P. patricia* there is *a fourth spot placed below the median nervure midway between the nodus and pterostigma*, covering two quadrilateral cells under the median and two smaller pentagonal cells beneath. No such spot exists in *P. apollo*. Fifth spot (under pterostigma) is placed in *P. patricia exactly* under the pterostigma but is not quite so wide as it; in *P. apollo* it is somewhat more rhomboidal in shape, and is placed half *before* and half *under* the pterostigma. Sixth (apical) spot slightly smaller than in *P. apollo*. All the spots in *P. patricia* brilliant crimson with darker borders; transparent, and appearing in a bright light as brilliant as a ruby. Spots of *P. apollo* (apparently) rich brown.

As in *P. apollo*, so in *P. patricia* there are two rows of cells in the postcostal area of the forewing. The pterostigma of *P. patricia* is somewhat shorter than that of *P. apollo*. As regards colouration, it is difficult to say what may be the true colours, in life, of the Chilian species; but I have never seen any dragonfly amongst the *Æschnidæ* which, in point of absolute beauty of colour and pattern, could vie with *P. patricia*. The deep rich reddish-brown of the abdomen, studded as it were with brilliant gems in the shape of the numerous green spots and markings, marks it out as standing alone amongst the *Æschnidæ* for absolute beauty; while the wonderful display of transparent red light in the wing-spots is quite unparalleled in that family. We may expect the male, when discovered, to be no exception to the general rule, but to outvie even the beauty of the female.

We must now turn our attention to the cast-skin of the nymph, which is a most remarkable object, and in many respects quite unlike any other known dragonfly nymph (see Plate lv., fig.1.):—

Total length 35 mm., abdomen 23 mm., head 5·5 mm. long by 9 mm. wide; width of prothorax 5·2 mm., of mesothorax 7·3 mm., of metathorax 8 mm. Greatest width of abdomen 10·8 mm. at segment 5. Wing-cases 7 mm. long.

Colour, a nearly uniform dull brown all over; nearly the whole of the upper surface of the head, thorax, legs, and abdomen finely granulate. Head large, of distinct *Æschnine* form; *eyes* very large and prominent, *postocular areas* very granulate, rounded behind, but with the margins irregularly wrinkled, and with a small tubercle projecting just behind each eye. *Vertex* large, broadly shield-shaped, the three *ocelli* set right at the back close to the prothoracic border; *antennæ* wide apart, 2·5 mm. long, seven-jointed, the three basal joints thickened, the four terminal ones thin, longer. (Probably the position of the ocelli and antennæ is too far back in the exuviæ, owing to the backward shifting of the vertex over the postocular area after transformation); *front*, *clypeus*, and *labrum* very granulate, the latter widest, bordered with a dark line on the lip, carrying a row of tiny close-set pale hairs. Labium very strong and muscular; basal joint very strong and thick, well rounded beneath, and nearly 2 mm. through. *Mentum* fairly flat, but very muscular; almost square, but slightly narrower basally and with the sides slightly curved; very strong and thick, being quite 1 mm. through on each side, lateral edges slightly upcurved and furnished with a row of very small spines; *median lobe* only very slightly prominent, edged with fine hairs. *Lateral lobes* carrying a very large sharply pointed outer tooth, from behind the basal portion of which there arises a large inner tooth, shorter and blunter than the outer one, and possessing a finely serrated inner edge (see Plate lv., fig.2). Thorax: *prothorax* well formed, with a prominent frontal collar and large upper and lower lateral spiny projections on each side; upper and lateral surface entirely granulate except for a small sunken double spot on each side of

dorsum. *Meso-* and *metathorax* large, wrinkled, raised high above level of abdomen. *Wing-cases* laid parallel, their upper sutures meeting at right-angles and slanting away downwards on each side at an angle of 45° to the dorsal line; smooth, very dark brown, with tiny black granular spots along the principal nervures, and a very dark patch on nodus of forewings only. *Legs* exceedingly wrinkled and furnished with several irregularly placed blunt spines on femora and tibiæ; surface of femora distinctly granulate, of tibiæ finely so; *tarsi* three-jointed, the two basal joints very short, the terminal one longer than the other two together and ending in two sharp reddish claws. Lengths of femur, tibia and tarsus respectively as follows :—fore-leg, 5, 5, 2·5 mm.; middle-leg, 6, 5, 3 mm.; hind-leg, 7, 6, 3·5 mm. Abdomen elongate-oval, flattened, widening gradually from 1 to 5, then narrowing slightly to 9; 10, very much narrower. Surface of all segments finely granulate except along sutures and on a series of small oval depressions, not easily noticed, arranged down each side of the dorsal surface. Each segment from 2 to 8 ends on each side in a remarkable protuberance of a peculiar curved form somewhat like a fin; these increase in size up to segment 8; in segments 2-5, these protuberances are distinctly upcurved, in 6 less so, in 7 nearly flat, while in 8 they are quite flat and broad. On 4-8 there are two small anal dorsal tubercles close together, and on 4-7 a second pair placed one on each side, farther from the dorsal line: 9 has flattened edges coming gracefully inwards anally, and then projecting out so as to enclose the basal part of 10: in 9 the two anal dorsal tubercles have practically coalesced to form one larger one: 10 small and possessing no tubercle. *Terminal appendages* five, of which the two outer (lateral) ones are longest, 2·2 mm., narrow conical, converging, pointed; the median one broader and shorter, 1·7 mm., subtriangular, tip truncate; the other two short, narrow subconical, 0·5 mm., lying on each side of median and above the inner portion of the lateral ones.

The discovery of this remarkable nymph should settle once and for all the true position of the *Petalia*-group of genera in our

systematic classification. Hitherto placed with the *Cordulegasterinæ*, they must now be removed from that subfamily, and either added to the true *Æschninæ*, or placed next to the latter in a small subfamily of their own. The argument in favour of this change may be stated as follows :—

(1) In studying the position of the *Petalia*-group of genera, from a knowledge of the imagines only, too much stress has been laid upon *one* characteristic, viz., the fact that their eyes only just touch, as is also the case with *Cordulegaster*. Mainly on this character, they have been included in the *Cordulegasterinæ*, this subfamily having been distinguished from the true *Æschninæ* by the fact that, in the latter, the eyes are closely contiguous for a considerable distance. As a matter of fact, this character is really of less importance than others which have been entirely ignored by systematists in placing this genus. In the *Libellulinæ* we can recall the case of two closely allied insects, viz., *Crocothemis erythræa* Brullé, and *Rhodothemis rufa* Rambur, in which the chief difference is that the eyes of the former are, like those of nearly all *Libellulinæ*, closely contiguous; while in the latter, the eyes barely touch, and, in some specimens which I possess, are *absolutely separated*. Yet in all other respects these insects are closely allied, and their divergence in this one characteristic is only sufficient to place them in two different but closely united genera. We ought, therefore, in the case of *Petalia* and allies, to examine whether, in other respects, they show a remarkably close similarity to *Cordulegaster* or not. That they do not, is clear from the fact that the ovipositor of the females of *Petalia* is quite unlike that of *Cordulegaster*, and is of the true *Æschnine* form, and still suitable for the placing of ova in submerged tissues, a power lost to *Cordulegaster*, whose ovipositor is so modified that the insect is unable to penetrate tissues, but can only deposit its eggs in mud and shallow water by laboriously supporting itself vertically with its wings, and dragging its abdomen in the mud. Again, as regards wing venation, the shortness of the wing-triangle, with its one cross-vein, is nearly paralleled by *Gomphœschna* and *Brachytron*, admittedly *Æschnine*

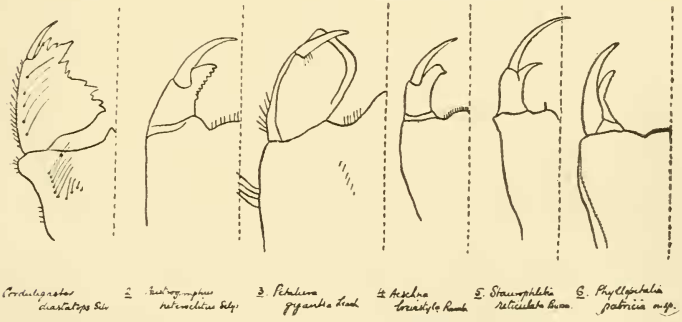
genera. While, on the other hand, the development of the anal area of the hindwing in *Petalia*, with its anal loop, is distinctly of an *Æschnine* form, that of *Cordulegaster* is more *Petalurine* in form. Hence, from a study of the imago only, we should be in doubt as to whether *Petalia* and allies were, or were not, after all, true *Æschnine* forms.

(2) As regards larval characters, I shall endeavour to show that, although the nymph of *Phyllopetalia* above described does possess one similarity to that of *Cordulegaster*, it is on the whole distinctly *Æschnine*.

As far as I can see, it is similar to *Cordulegaster* in one respect only, *viz.*, that it is apparently a liver amongst débris and trash on the bottom of the swift mountain-creeks. It possesses a curiously wrinkled body-surface, rough legs, and flattish abdomen, which go to prove this to be its habit of life. Against this we must set the following considerations :—

(*a*) The shape of its head, with its large rounded eyes and narrower curved postocular lobes, is distinctly *Æschnine*.

(*b*) A study of the labium is of the greatest importance in systematic classification, and the evidence it affords should go far to outweigh any argument based on less certain characters.



In the text-figures I give outline sketches of the labia of six genera which bear on the point at issue. Fig.1 represents that of *Cordulegaster diastatops* Selys; fig.2 of *Austrogomphus heteroclitus* Selys; fig.3 of *Petalura gigantea* Leach; fig.4 of *Æschna*

brevistyla Ramb.; fig.5 of *Staurophlebia reticulata* Burm.; and fig.6 is the labium of our new species, *Phyllopetalia patricia*. Of these, 1 belongs to the *Cordulegasterinæ*, 2 to the *Gomphinæ*, 3 to the *Petalurinæ*, and 4 and 5 to the true *Æschninæ*.

The most evident thing about them is that No.1 is of quite a different type from the other five. In it we have the development of mental and lateral setæ which characterises the *Libellulinæ* and *Corduliinæ* alone amongst the *Anisoptera*; while the triangular mentum, which when closed is hollow and almost cup-shaped, is also characteristic of these groups. Turning more especially to the lateral lobes, we notice the small movable tooth or hook, and the irregularly serrated inner margin of the lobe, which is itself broad and well-developed. Such characters are very close to those displayed by the nymphs of *Corduliinæ*, though, in that subfamily, irregular serration of the inner margin is replaced by more or less regular crenation.

In all the other five, we have a quite different type of labial development. Firstly, the mentum is broad and flat, not much narrowed at the base, and in repose is laid flat against the underside of the head. Neither mental nor lateral setæ are developed. The main attacking strength of the weapon lies in the great development of the "movable hook," which is now a huge tooth. The lateral lobe itself is not broad (except in *Petalura*), nor does it show on its inner margin any sign of dentation (except in *Austrogomphus*, which, as in many other *Gomphinæ*, has a finely serrate margin, while under a lens that of *Phyllopetalia* may be seen to be exceedingly finely serrate). With all their variations in the shape of the inner lobe, and the length of the large outer tooth, these five labia clearly represent phases of one line of labial development, which is recognised as being peculiar to the family *Æschnidæ* (excluding *Cordulegaster* for the present). The labium of *Phyllopetalia* itself is peculiar in having the large outer tooth reaching the whole length of the lateral lobe, and apparently jointed, if at all, on to the mentum; while the second and smaller tooth of the lateral lobe appears from behind it. Here is a development unparalleled by any other known genus of *Odonata*.

However, there is in some ways a very close resemblance between Nos.2 and 6, though the value of the comparison is lost for us, as systematists, by the evident differences, in other respects, between both nymphs and imagines of the *Gomphinæ* and *Phyllopetalia*. In the *Æschninæ* (figs.4 and 5) the usual form of the inner margin of the lateral lobe is the more or less squarely truncated end as shown in fig.4. But that other forms are still extant, may be seen in fig.5 (*Staurophlebia reticulata* Burm.), where both the large outer tooth and the smaller tooth of the inner margin are sharply pointed.

A further argument in favour of the similarity between the labial development of *Phyllopetalia* and that of the *Æschninæ* will be forthcoming on the publication by me, later on, of the life-history of *Telephlebia godeffroyi* Selys. The material for this paper is not yet worked up, but I am able to state that the labium of this remarkable primitive *Æschnine* form shows an even closer resemblance to that of *Phyllopetalia* than do any of the labia figured in the text.

To sum up, it seems to me that *Phyllopetalia* and *Cordulegaster* are by no means closely allied. In their nymphal stages the members of the latter genus exhibit remarkable structural differences from all the rest of the *Æschnidæ*, and should probably be separated out as a subfamily by themselves, and connected more closely to the *Corduliinæ* by way of *Macromia* and *Synthemis*. *Phyllopetalia*, on the other hand, is probably less closely allied to *Cordulegaster* even than *Petalura* is, and must at any rate be removed from the *Cordulegasterinæ*. In my opinion, its correct position should be in the *Æschninæ* proper, next to *Telephlebia*, thus including in this subfamily all those genera in which the ovipositor of the imago is a true terebra or "borer."

As regards the nymphs, the following key will now serve to separate them :—

1.	Antennæ 4-jointed	*Gomphinæ*.
	Antennæ 7-jointed	2.
2.	Labium with mental and lateral setæ, small terminal movable hook, and large irregular serrations on inner margins of lateral lobes	*Cordulegasterinæ*.
	Labium with no setæ, large terminal tooth, little or no crenation of inner margin	3.

3. { Lateral lobe of labium very large, rounded..... *Petalurinæ*.
Lateral lobe of labium small and narrow, with tip variously shaped..... *Æschninæ* (including *Phyllopetalia*).

In conclusion, I should like to express my thanks to my friend, Dr. Ris, for first pointing out to me the similarity between the ovipositors of *Phyllopetalia* and the true *Æschninæ*. The consequent conviction that *Phyllopetalia* was a true *Æschnine* genus is, I trust, happily vindicated by the present paper, on the evidence of this truly remarkable nymphal form.

EXPLANATION OF PLATE LV.

Phyllopetalia patricia, n.sp.

Fig. 1.—Exuviæ(× 2).
Fig. 2.—Labium (much enlarged).
Fig. 3.—Female imago (nat. size).